XAS Study of Co In Plasma Sprayed WC/Co Coatings On Steel

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Plasma spraying of wear resistant WC coatings onto steel machine parts has become a standard method to dramatically prolong their useful life. The use of nano-composite admixtures of elemental Co (at the 10-20% level) and WC powders for this plasma deposition has proved to optimize the wear resistance and durability of these coatings. However, while X-diffraction measurements on the coatings can clearly identify the W-C phases present, the Co component has eluded structural identification, presumably due to its amorphous character.

In Figure 1 we compare the Co-K edges of elemental Co and a plasma sprayed WC/Co coating on steel, and wish to note a number of points. The overall chemical shift of the edge remains close to that of elemental Co which argues against any large-scale carbonization or oxidation of the Co in the plasma spray (PS) deposition process. The first peak above the absorption edge, for the elemental-Co case, exhibits a sharp bimodal character whereas for the Co-in-the-coating case a single broadened peak is observed. Indeed, in general, the features for the Co/WC coating are much broader, and of much lower intensity, than the elemental case. This broadening and degradation of the PS coating's spectral features is dramatically apparent in the fine structure (FS) oscillations (over a wider energy range) shown in the inset of Figure 1. This effect indicates the presence of very strong disorder in the PS coating. It is important to note, that the centrum of the FS oscillations of the two spectra coincide rather well. Finally we would like to note that the 5'th positive peak in the FS is clearly split for elemental-Co, but is a single broad feature for the Co in the PS coating.

Previous shell-by-shell multiple scattering modeling of Fe in an fcc structure [1] bear directly on these Co results. From these calculations it can be inferred that the overall similarity in the FS oscillations in Figure1-inset is consistent with the 1'st and 2'nd coordination shells of the Co in the PS coating being similar to those in elemental-Co. Similarly, the loss of the splitting of the 1'st and 5'th peaks in the FS are entirely consistent with the strong disorder reduction in the contributions of the 3'rd and 4'th atomic shells in the amorphous-Co in the PS coating. The dramatic reduction in the amplitude of the FS oscillations in the coating spectrum is consistent with substantial vacancy/disorder effects in the 1'st and 2'nd atomic coordination shells. Thus the XAS results indicate that the Co in the PS WC/Co coating occurs in a highly disordered amorphous metallic phase closely related to elemental Co in the first two coordination shells.

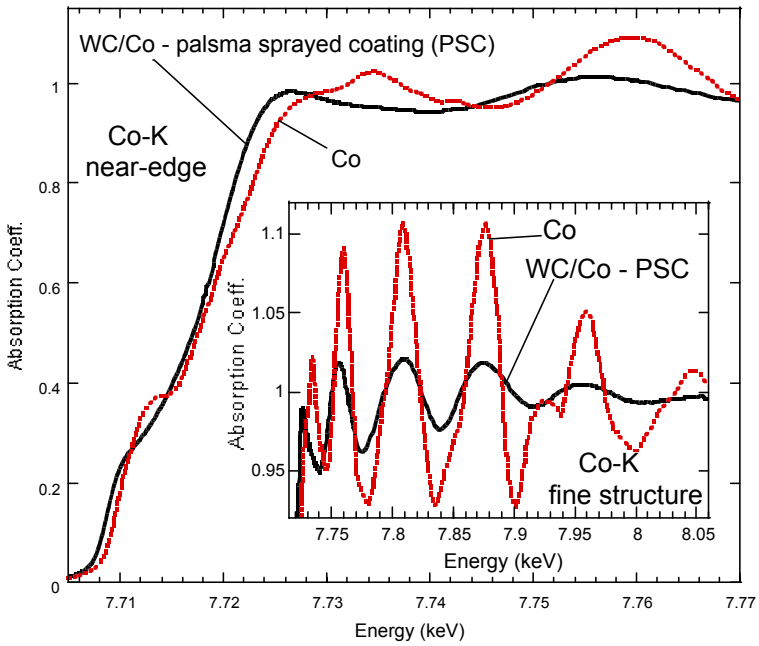

Figure 1. The Co-K spectra of elemental Co and of Co in a plasma sprayed coating of WC/Co. (inset) The fine structure (FS) XAS oscillations above the Co-K edge for these same two materials.

References: [1] M. Croft, D. Sills, A. Sahiner,A. F. Jankowski, P. H. Ansari, E. Kemly , F. Lu, Y. Jeon, T. Tsakalakos, Nanostruct. Mat. **9**, 413-422(1997)